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Remarks:
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(54) Drive circuit for brushless motor

(57) A driving circuit for a brushless motor for synchronizing the commutation timing with a timing for increasing or decreasing the armature winding current comprises:

a rotor location detection means (4) for detecting a relative location of the armature windings and the rotor;

a commutation control means (9) for switching a current to an armature winding at a detected rotor location;

a speed detection means for detecting a speed of actual rotor speed;

a speed difference detecting means (409) for outputting a difference between an actual rotation speed of the rotor and target rotation speed as a speed difference signal; said

a speed difference compensation filter (410) for obtaining a current indication value from detected speed difference signal in order to drive the armature winding;

said commutation control means switch the current supplying phase and increase or decrease the current indication value which is applied to the armature winding after a predetermined period.

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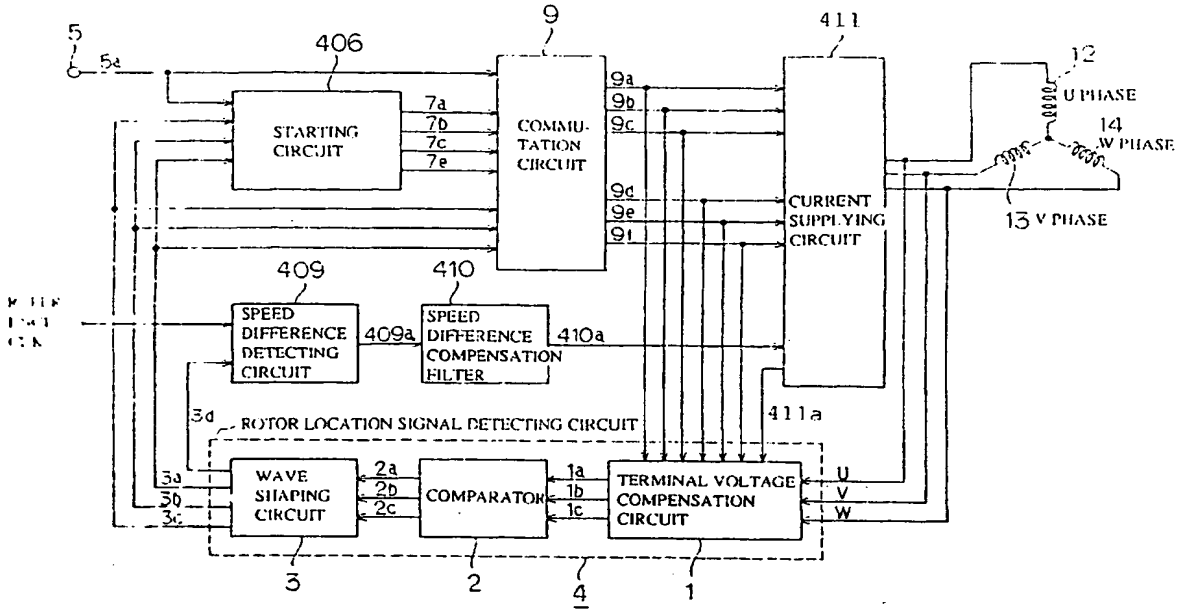

FIG. 1

Description

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to drive circuit for the brushless motor.

Description of the Prior Art

The rotation driving control of a brushless motor can be classified roughly into two functions. One of which is a commutation control for controlling the timing of respective phase current which flows through respective armature winding. Another is a speed control which maintains the rotation speed constant.

In the commutation control, a rotor location signal is necessary which indicates the relative position of the armature winding and the rotor. On the other hand, in the speed control, a speed signal is necessary for indicating rotation speed of the rotor.

For the commutation change control of conventional typical brushless motor, a rotor location detecting element such as Hall device is used. But, since the rotor location detecting element is no so cheap and needs further many electric wiring, there is some demerit which is complicated and causes an increase of cost.

FIG. 5 shows a block diagram of a speed control system of the driving circuit for conventional brushless motor. In FIG. 5, 530 is a speed detecting circuit which detects actual rotation speed of the rotor and outputs a speed signal, 531 is a speed difference detecting circuit which outputs a speed difference signal having a pulse width corresponding to the speed difference by counting the speed signal period using reference clock. A speed difference compensation filter 532 outputs a current indication value to a current supplying circuit 533 so that a speed difference becomes zero according to the speed difference signal. The current supplying circuit 533 regulates a current quantity supplied to the armature winding of the brushless motor 534 according to the current indication value. In the driving circuit of such conventional brushless motor, the speed difference compensation filter is constituted of an analog filter in which a PI filter 460 and a first order delay filter 464 are connected serially as shown in FIG. 6.

In the driving circuit of the conventional brushless motor, the speed signal period is counted by the reference clock and therefore the reference clock frequency inputted into the speed difference detecting circuit is switched in proportion to the indicated rotation speed when the indicated rotation speed to the motor is switched.

In the conventional driving circuit for the brushless motor, a commutation timing is not synchroniz d with a timing for increasing or decreasing the armature winding current. Therefor , it is difficult to add or subtract a compensation value which is determined by the resistance value of the armature winding and the current flowing in the current supplying phase to/from the winding voltage during the actual driving period.

It is the object of the present invention to provide a driving circuit for the brushless motor for synchronizing the commutation timing with a timing for increasing or decreasing the armature winding current.

SUMMARY OF THE INVENTION

The brushless motor driving circuit of the present invention comprises a rotor detection means for detecting a relative location of the armature windings and the rotor; a commutation control means for switching a current to an armature winding at a detected rotor location; a speed detection means for detecting a speed of actual rotor speed; a speed difference detecting means for outputting a difference between an actual rotation speed of the rotor and target rotation speed as a speed difference signal; the a speed difference compensation filter for obtaining a current indication value from detected speed difference signal in order to drive the armature winding; the commutation control means switch the current supplying phase and increase or decrease the current indication value which is applied to the armature winding after a predetermined period.

Since the current is sequentially increased or decreased after current phase is switched within a predetermined period, the current is easily feedbacked to compensate the terminal voltages.

Further, the brushless motor driving circuit of the present invention, a maximum current is supplied to the armature windings during a period of starting and restarting.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of an embodiment which shows a general construction a brushless motor driving device.

FIG. 2 is a signal waveform which explains an operation of a driving circuit for the brushless motor of an embodiment 1.

FIG. 3 Is a block diagram of a second embodiment of present invention which shows a general construction a brushless motor driving device.

FIG. 4 Shows a construction of a speed difference compensation filter of the embodiment 2.

FIG. 5 is a block diagram which shows a speed control system of a conventional brushless motor driving device.

FIG. 6 Is a block diagram which shows a speed difference compensation filter of a conventional brushless motor driving device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiment 1

FIG. 1 is a block diagram of a general construction of a brushless motor driving device. In FIG. 1, the numeral 406 denotes a starting circuit, the numeral 409 denotes a speed difference detecting circuit for counting a period of the speed signal 3d by the counter and for outputting a period difference between the indicated value and the measured value as a speed difference detection signal 409a. The numeral 410 denotes a speed difference compensation filter for supplying a current indication value 410a to a current supplying circuit 411 so that the speed difference detection signal 409a become zero. A current supplying circuit 411 comprises a resistor 10, a bridge circuit 11, a buffer amplifier 212, a resistor 213 and a driving transistor 214, and supplies a predetermined driving current to the armature windings 12, 13 and 14 according to the driving signals 9a ~ 9f.

A terminal voltage compensation circuit 1, a comparator 2 and a waveform shaping circuit 3 constitute the rotor location signal generating circuit 4.

In this embodiment, a relation is explained between the switching timing for switching the current supplying phase and the timing for increasing or decreasing the supply current to the armature windings of the brushless motor driving circuit of the present invention.

FIG. 2 shows a timing chart for explaining an operation of the brushless motor driving circuit at a normal direction. In FIG. 2, the numerals 3a, 3b and 3c represent rotor location signals, the numerals 9a ~ 9f represent driving signals, the numeral 3d represents a logic pulse signal indicating a speed, the numeral 409a represents a speed difference signal, the numeral 410a represents a current indication value. At a normal rotation, the driving signals 9a ~ 9f is generated by the rotor location signals 3a, 3b and 3c. Accordingly, at a normal rotation, the switching of the current supplying phase is carried out at the timing shown in FIG. 2.

The logic pulse singnal 3d is a both edge differential pulse of the rotor location signals 3a, 3b and 3c. The speed difference detecting circuit 409 measures a period of the speed signal 3d, and outputs a period difference which is a difference between the target value and the measured value as a speed difference detection signal 409a at a timing shown in FIG. 2. The speed difference detection signal 409a is inputted into the speed difference compensation filter 410. The speed difference compensation filter 410 carries out a filter arithmetic operation so that the speed difference detection signal 409a becomes zero.

Since it takes a certain time to carry out the filter arithmetic operation, change of the current indication value 410a delays by the operation time period after the speed difference detection signal 409a has changed. The current supplying circuit 411 regulates the current quantity which is supplied to the armature winding.

As mentioned above, in the brushless motor driving circuit of the invention, a switching timing is synchronized with a timing for increasing and decreasing the armature winding. Therefore, the timing for increasing and decreasing the current supplied to the armature winding is delayed for a period in corresponding to the arithmetic operation after the commutation has carried out.

Embodiment 2

In this embodiment, a brushless motor driving circuit for supplying a maximum current to the armature winding during the starting and restarting is explained.

FIG. 3 is a block diagram which shows a general construction of a brushless motor driving circuit. That is, in this construction, the switching signal 450a is input into the speed difference compensation filter 410.

FIG. 4 shows a construction example of a speed difference compensation filter. In FIG. 4, the numeral 600 denotes a micro controller, the numeral 601 denotes a D/A converter, the numeral 602 denotes a register group comprised of registers O ~ N in the micro controller 600. A speed difference detection signal 409a inputs into the micro controller 600. The micro controller 600 carries out a filter arithmetic operation and stores the result into the register N. Further, the micro controller 600 outputs the value which is stored in the register N to the D/A converter 601 at a predetermined timing. The digital value stored in the register N is converted into an analog value in the D/A converter 601 and outputted to the current supplying circuit 411 as a current indication value 410a.

The switching signal 450a for switching the starting mode and the normal rotation mode is inputted into the micro controller 600. The switching signal 450a is at L level until the predetermined period passed and at H level after then. The micro controller 600 initiates the register N, when the switching signals 450a becomes L level, and then set the value of register N to maximum.

Accordingly, the current indication value 410a is set to maximum value during the switching signal 450a is at L level, then a maximum current is supplied to the armature winding during a period of starting and restarting.

Claims

1. The brushless motor driving circuit comprising:

   a rotor location detection means for detecting a relative location of the armature windings and th rotor;

   a commutation control means for switching a current to an armatur winding at a detected

rotor location;

a speed detection means for detecting a speed of actual rotor speed;

a speed difference detecting means for outputting a difference between an actual rotation speed of the rotor and a target rotation speed as a speed difference signal; said

a speed difference compensation filter for obtaining a current indication value from detected speed difference signal in order to drive the armature winding;

Said commutation control means switch the current supplying phase and increase or decrease the current indication value which is applied to the armature winding after a predetermined period.

2. The brushless motor driving circuit of claim 1 wherein

a maximum current is supplied to the armature windings during a period of starting and restarting.

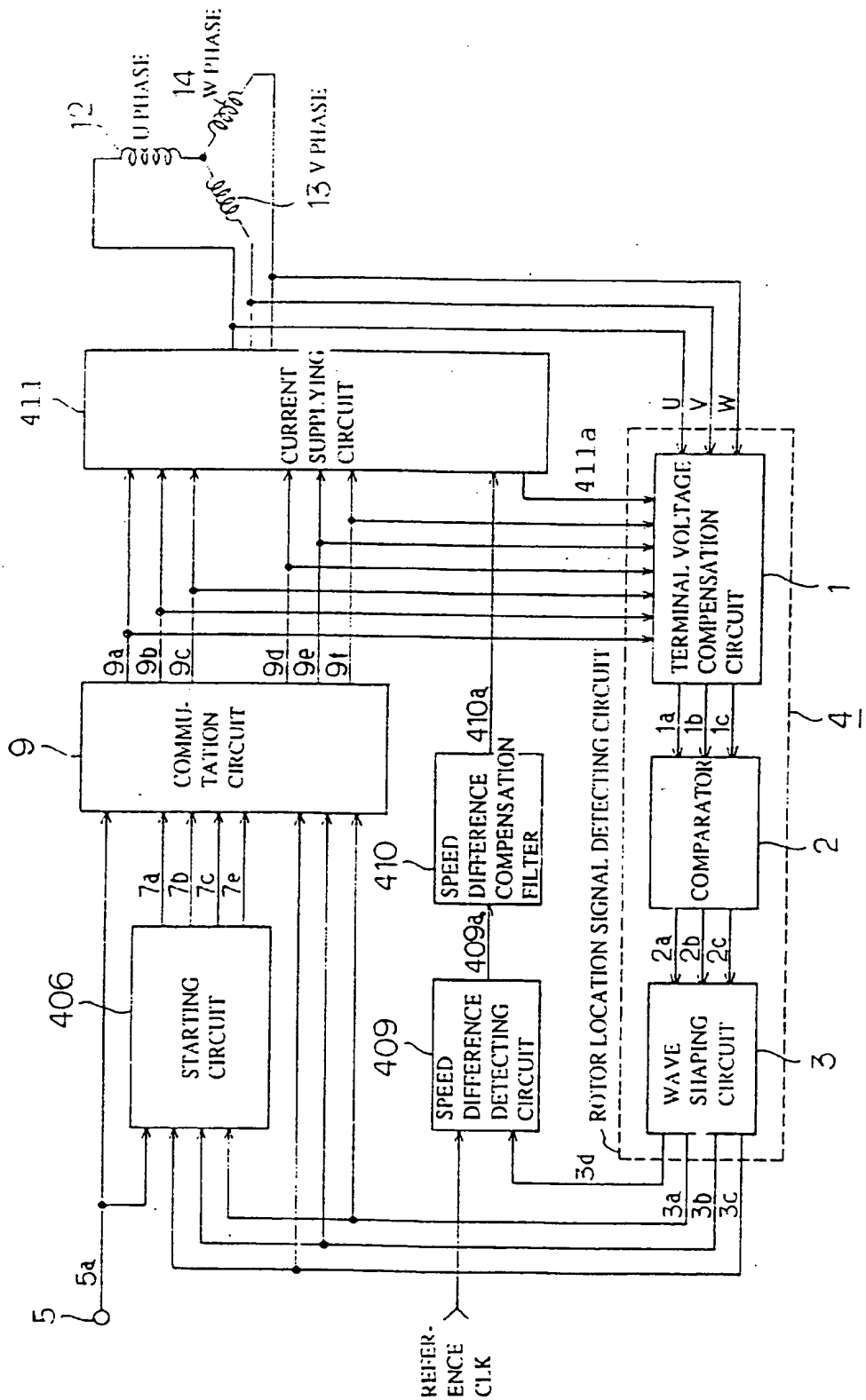

FIG. 1

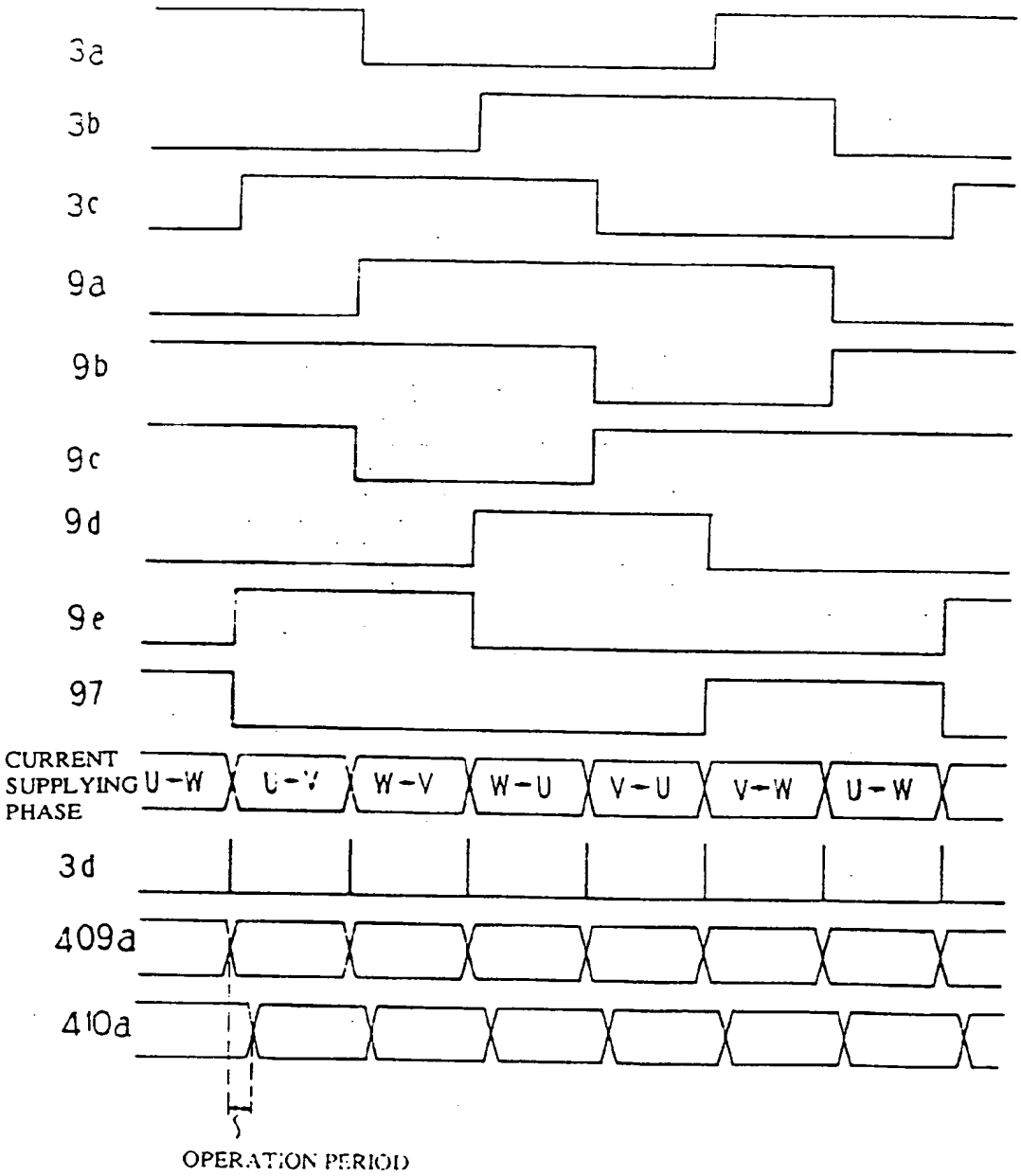

FIG. 2

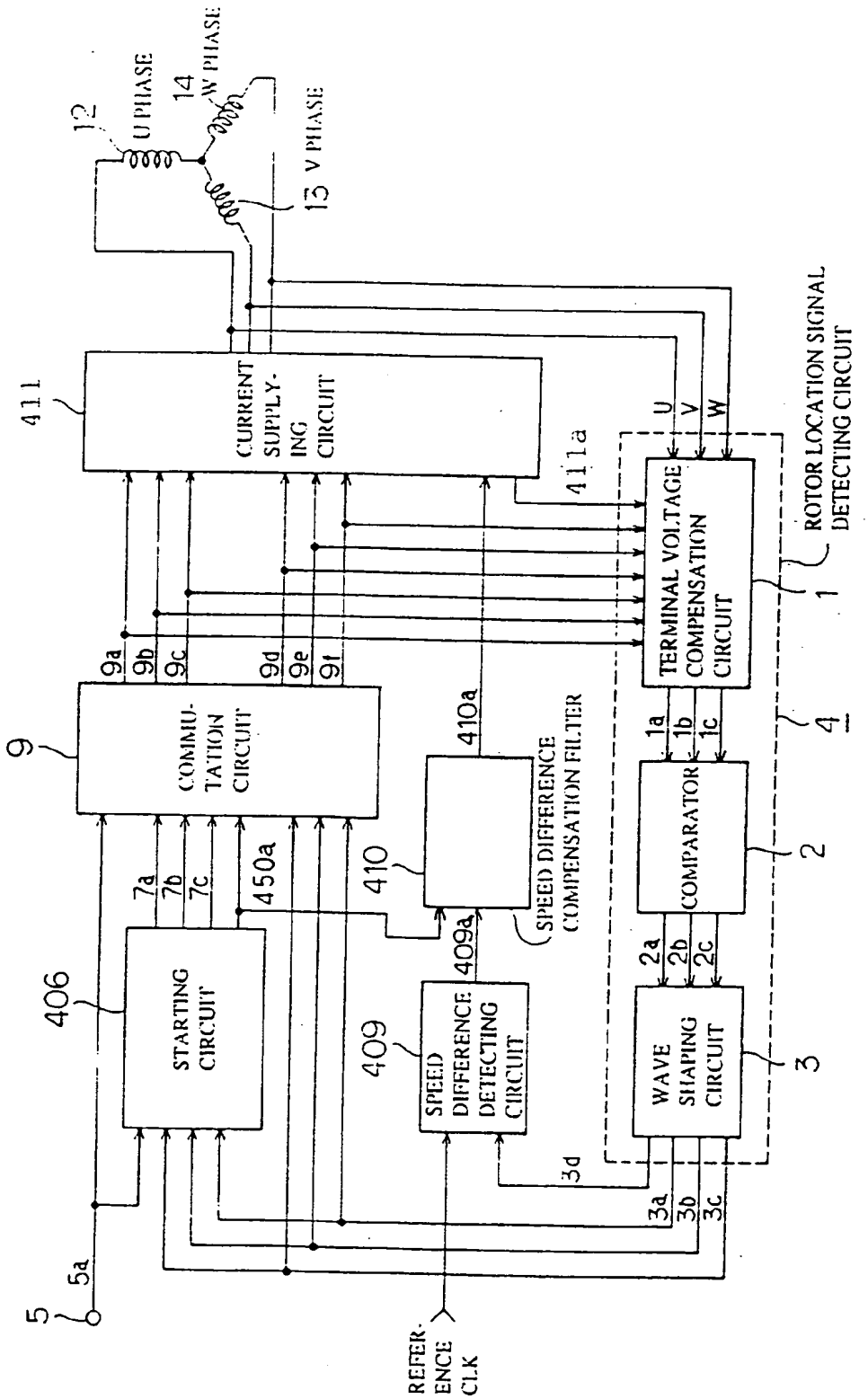

FIG. 3

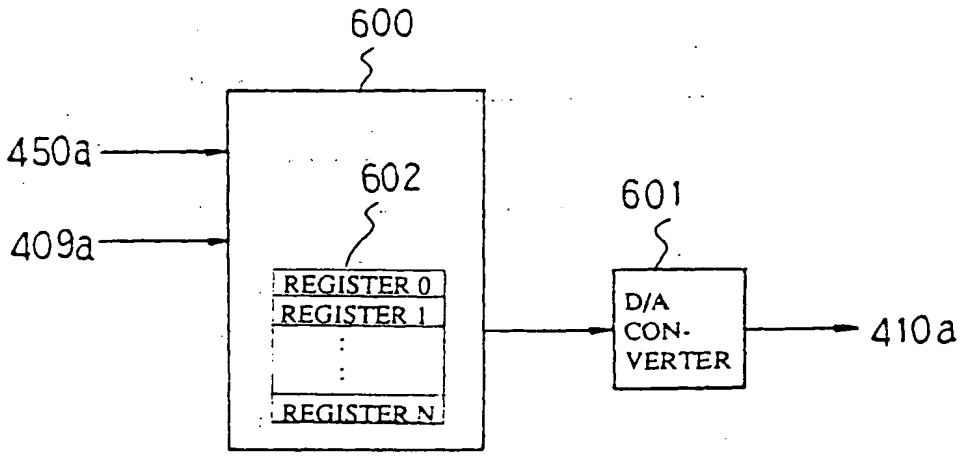

FIG. 4

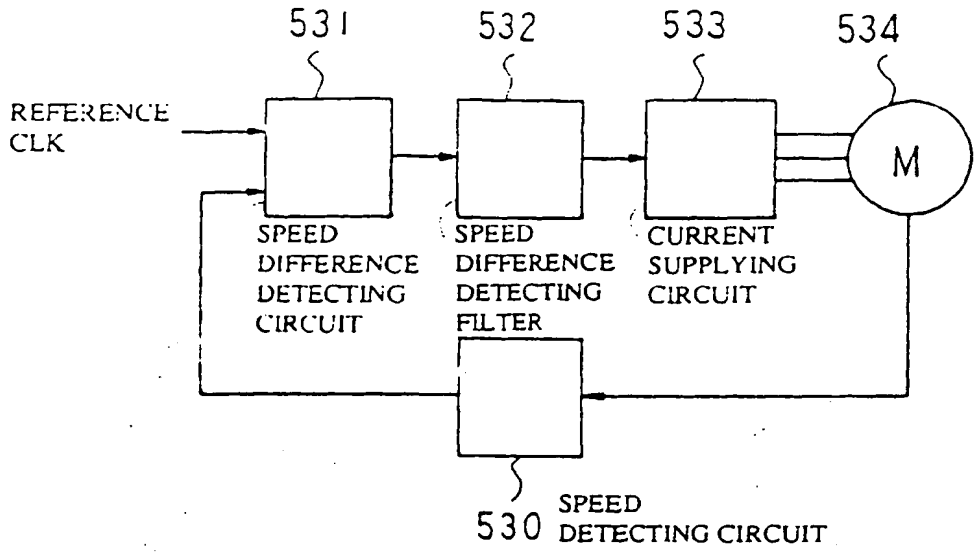

FIG. 5

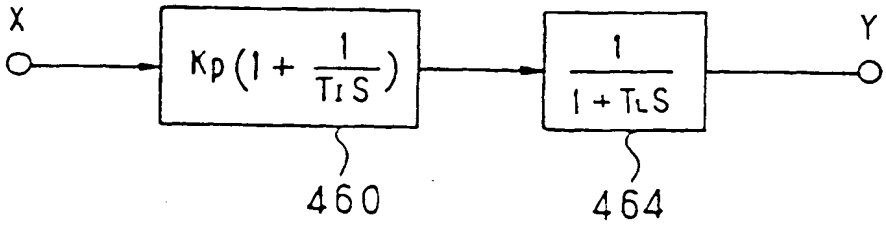

FIG. 6

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a speed difference compensation filter (410) for obtaining a current indication value from detected speed difference signal in order to drive the armature winding;

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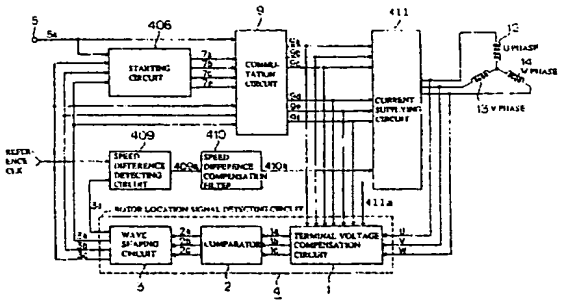

FIG. 1

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EUROPEAN SEARCH REPORT

Application Number
EP 98 25 0330

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	PATENT ABSTRACTS OF JAPAN vol. 012, no. 367 (E-664), 30 September 1988 & JP 63 117684 A (SANYO ELECTRIC CO LTD), 21 May 1988 * abstract *	1,2	H02P6/00
X	PATENT ABSTRACTS OF JAPAN vol. 007, no. 076 (E-167), 30 March 1983 & JP 58 003596 A (FUJITSU KK), 10 January 1983 * abstract *	1,2	
X	PATENT ABSTRACTS OF JAPAN vol. 011, no. 187 (E-516), 16 June 1987 & JP 62 016088 A (HITACHI LTD), 24 January 1987 * abstract *	1,2	
A	US 4 605 885 A (MITSUHASHI MASAMICHI) 12 August 1986 * claim 1 *	1,2	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H02P

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	19 November 1998	Bourbon, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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